DISTRIBUTION OF TRACE ELEMENTS IN THE LUMBAR ENLARGEMENT OF THE SPINAL CORD FROM THE RESULTS OF SPECTRAL ANALYSIS

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The experimental data reported in the literature on the chemistry of the nervous system are mainly concerned with the chemical topography of the cerebral cortex [1, 2, 3]. Valuable results have been obtained by the method of spectral analysis [4, 5]. So far as the study of the chemical topography of other divisions of the central nervous system, for example the spinal cord is concerned, there are only isolated reports on highly specialized problems [1, 2].

We endeavored to study the distribution of the trace elements in the various regions of the lumbar enlargement of the spinal cord morphologically and functionally by the method of spectral analysis: in the grey and white matter, separately, in the grey matter of the posterior and anterior horns, and in the posterior and anterior roots.

EXPERIMENTAL METHOD

The experiments were performed on the spinal cords of cows obtained from the Dnepropetrovsk Meat combine from 7-12 minutes after the animals had been killed by severing the carotid arteries. The spinal cords were delivered to the laboratory of the Department in vacuum flasks on ice. For removal of weighed samples the spinal cord was placed ona watch glass, cooled on ice, and the dura and arachnoid taken away; afterwards the posterior and anterior roots were divided separately. Before removal of the samples from the cord, it was placed with its anterior surface uppermost. From the base of the anterior median fissure lateral incisions are made on both sides, 2-3 mm in depth, in order to detach the grey matter of the posterior horn and the tissue of the anterior horn, and the margins of the incision are carefully drawn aside. From above along the edges, the tissue of the grey matter of the anterior horns is laid bare, and in the center along both sides of the central canal – the tissue of the gray matter of the posterior horns, and underneath it, after removal of the grey matter, the tissue of the white matter of the spinal cord.

Samples of tissue weighing 1 g were dried in platinum crucibles at a temperature of 105°C to constant weight, then in the same crucibles they were incinerated in a muffle furnace at a temperature of 400-420°C for 8 hours.

The test samples were ignited in needle electrodes before the aperture of the spectrograph, the electrodes being cleaned by A. K. Rusanov's method [6]. The film was taken on a ISP-22 spectrograph. The source of excitation was a Svetnitskii activated arc; the generator a PS-39. The spectrum was deciphered on a spectro-projector PS-18 by means of S. K. Kalinin's atlas of spectral lines. Quantitative analysis of the trace elements in the samples was carried out by means of standards prepared by A. O. Voinar's method. The degree of blackening of the analysed lines was measured on a MF-2 microphotometer.

EXPERIMENTAL RESULTS

The results of qualitative analysis showed that the ash of the lumbar enlargementof the spinal cord and of

Concentration of Trace Elements in the Lumbar Enlargement of the Spinal Cord Calculated as Ash (in percent)

Area of the lumbar enlargement of the spinal cord tested	Lead	Chromium	Nickel	Aluminum	Manganese	Silicon	Titanium	Copper	Silver
The whole area	0.0003	0.001	0.001	0.0031	0.0005	0.001	0.002	0.0055	Traces
White matter	0.0019	0.001	0.001	0.0075	0.001	0.004	0.002	0.022	»
Gray »	0.0004	0.001	0.0015	0.0066	0.0015	0.002	0.003	0.003	»
« » of the anterior horn	0.0002	0.0005	None	0.0072	0.0005	0.003	0.002	0.002	»
« » of the posterior horn	0.0006	0.0014	0.001	0.0057	0.0025	0.001	0.002	0.004	0.001
Anterior root	0.0009	0.001	0.001	0.0038	0.0005	0.005	0.003	0.003	Traces
Posterior root	0.001	0.001	None	0.0006	0.0003	0.006	0.003	0.001	»

its emerging roots contains the following elements: calcium, potassium, magnesium, sodium, phosphorus, iron, chromium, aluminum, nickel, silver, titanium, copper, silicon, lead, manganese, zinc, cobalt and tin. The first six elements are found in larger quantities than the rest; they may be regarded as the macroelements of the spinal cord. Their quantitative analysis was not undertaken.

In view of the low threshold of sensitivity and the high volatility of zinc during ignition of the ash, its estimation by the method of emission spectral analysis was difficult. To estimate zinc a chemical method must be used. In estimation of cobalt it was found that its line was covered by lines from iron; this made the quantitative analysis of cobalt difficult.

The following trace elements were selected for quantitative analysis in the lumbar enlargement of the spinal cord: lead, chromium, nickel, aluminum, manganese, silicon, titanium, copper and silver. The results of the quantitative estimation of the trace elements in various areas of the lumbar enlargement of the spinal cord and the roots are shown in the table.

By examination of the numerical results relating to the individual trace elements we obtain the following.

Lead is uniformly distributed throughout all the tested areas of the lumbar enlargement of the spinal cord in an amount of $10^{-4}\%$ calculated as ash, with the exception of the white matter and the posterior roots, where its concentration reaches $10^{-3}\%$ calculated as ash.

Chromium is uniformly distributed throughout all the tested areas in a concentration of $10^{-3}\%$ calculated as ash, with the exception of the anterior horn of grey matter, where it is slightly less.

Nickel is unevenly distributed. It is not found in the grey matter of the anterior horn nor in the posterior roots. In the remainder of the tested areas of the spinal cord the nickel content is $10^{-3}\%$ calculated as ash.

Aluminum occupies the second place after copper in its content in the tested areas of the spinal cord. It is unevenly distributed. Its highest concentration ($10^{-3}\%$ calculated as ash) is in the white matter and in the grey matter of the anterior horn; it is slightly less in the grey matter (as a whole) and in the grey matter of the posterior horn. Its concentration is less by, roughly, one half in the tissues of the anterior roots and when calculated for the whole area of the spinal cord. Its concentration calculated as ash in the posterior roots is around $10^{-4}\%$.

Manganese is present in all the tested areas in a concentration of $10^{-3}\%$ calculated as ash. In the grey matter of the posterior horn it is present in roughly 5 times the concentration in the grey matter of the anterior horn.

Silicon is concentrated mainly in the posterior and anterior roots and in the white matter in an amount of 10^{-3}% calculated as ash. This is evidently connected with the relatively high content of supporting tissue in these regions, characterized by a content of silicon.

Titanium is distributed uniformly throughout all the tested areas of the spinal cord in a concentration of 10^{-3}% calculated as ash.

The spinal cord is richest of all in copper. In the white matter its concentration is 10^{-2}% calculated as ash, and in other areas 10^{-3}% calculated as ash. The distribution of copper is as follows: relatively more in the grey matter of the posterior horn, slightly less in the anterior root, still less in the grey matter of the anterior horn and least of all in the posterior root.

Among the tested trace elements, silver was found to have the smallest concentration. In all the tested areas of the spinal cord only slight traces were found although in the grey matter of the posterior horn the silver content was 10^{-3}% calculated as ash.

According to their content of trace elements (in percent, calculated as ash) the tested areas of the lumbar enlargement of the spinal cord and the roots arising therefrom may be arranged in the following descending order:

White matter	0.0404
Grey matter (as a whole, without subdivision)	0.0190
Grey matter of the posterior horn	0.0183
Anterior root tissue	0.0182
Grey matter of the anterior horn	0.0154
Tissue of the whole area of the lumbar enlargement	0.0144
Posterior root tissue	0.0120

According to their quantitatively estimated concentrations (in percent as ash) in the lumbar enlargement of the spinal cord and in the roots, the trace elements tested may be arranged in the following order:

Copper	0.0060	Manganese	0.0010
Aluminum	0.0052	Nickel	0.0008
Silicon	0.0030	Lead	0.0007
Titanium	0.0020	Silver	0.0001
Chromium	0.0010		

It has thus been established by the method of emission spectral analysis that there is an unequal distribution and content of the trace elements in the lumbar enlargement of the spinal cord and in the roots arising from it.

SUMMARY

The quantitative content of microelements was investigated in various areas of the lumbar part of the spinal cord in cows. The method of spectral emissional analysis was applied. It was established that microelements (lead, chromium, nickel, aluminum, manganese, silicon, titanium, copper and silver) are distributed unevenly in the white matter, grey matter of the anterior horn, posterior horn, anterior and posterior roots of the spinal cord. The data which were obtained support the conception of Academician A. V. Palladin that brain areas which differ in their morphological structure and physiological function vary in their chemical content.

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